

PRELIMINARY DATA SUMMARY

December 1987

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Field Research Facility Measurement and Analysis Work Unit at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility in Duck, North Carolina. The data were collected and the analyses performed by the FRF staff. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Herman C. Miller at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

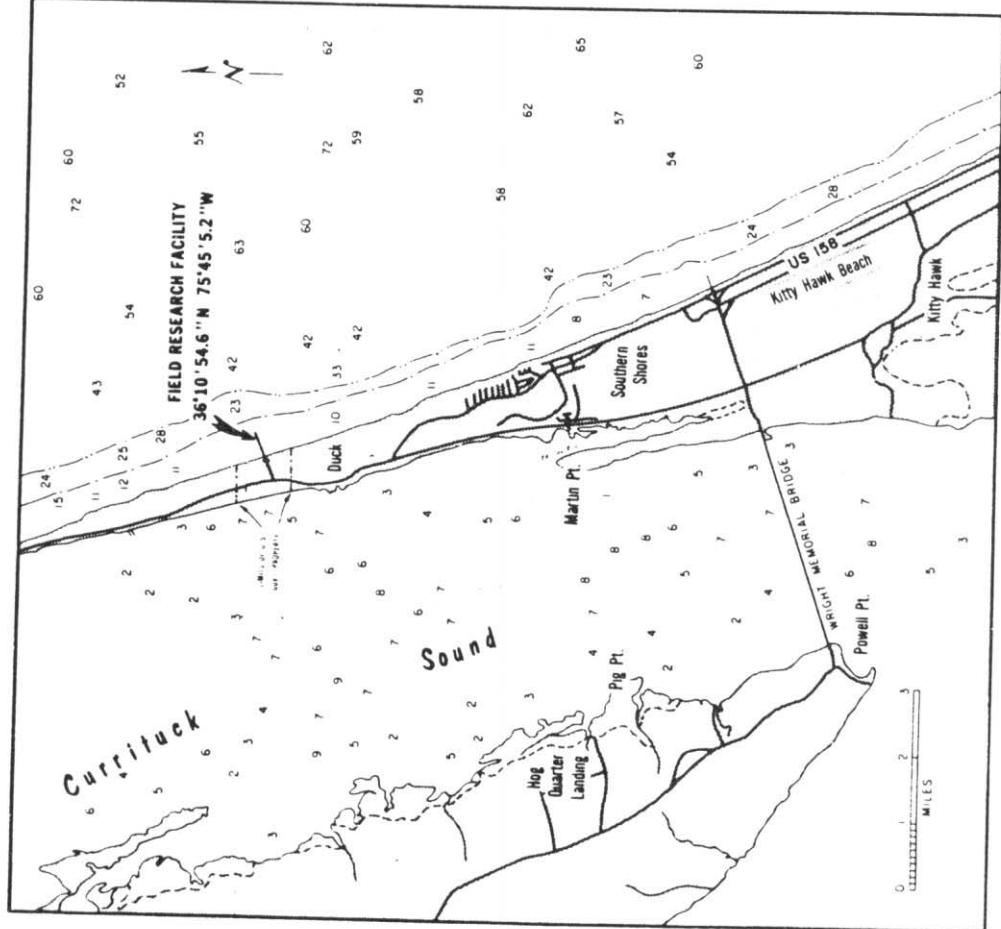
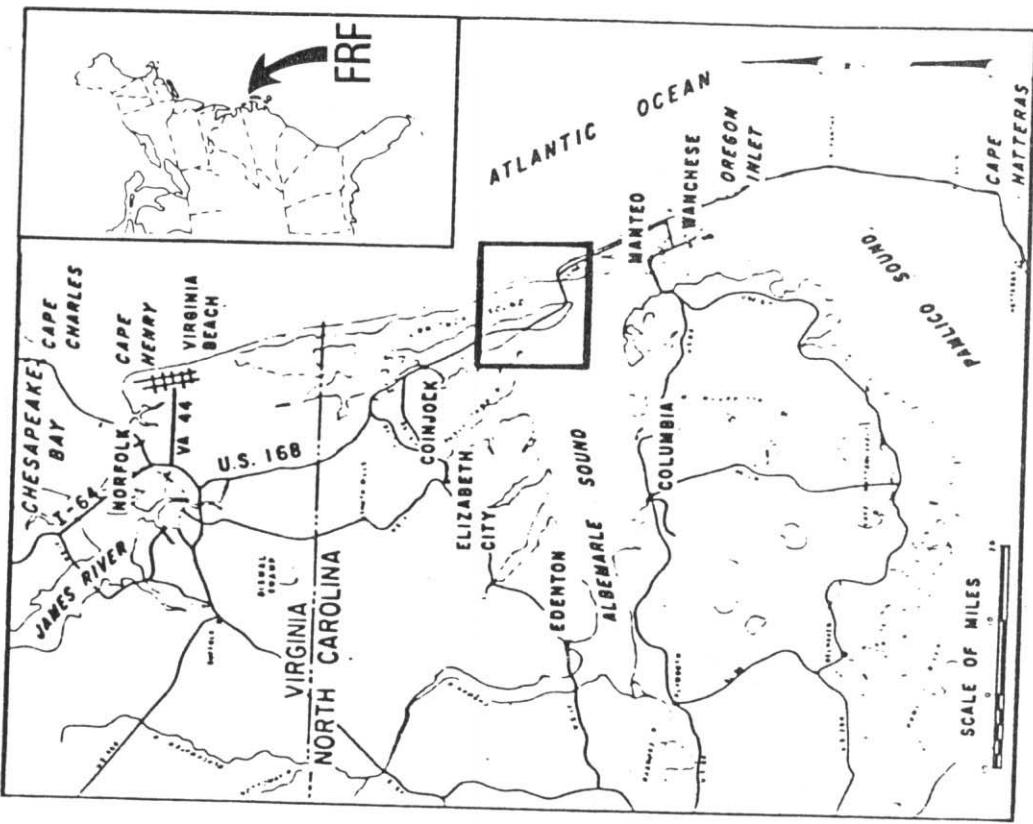


Figure 1. FRF location map

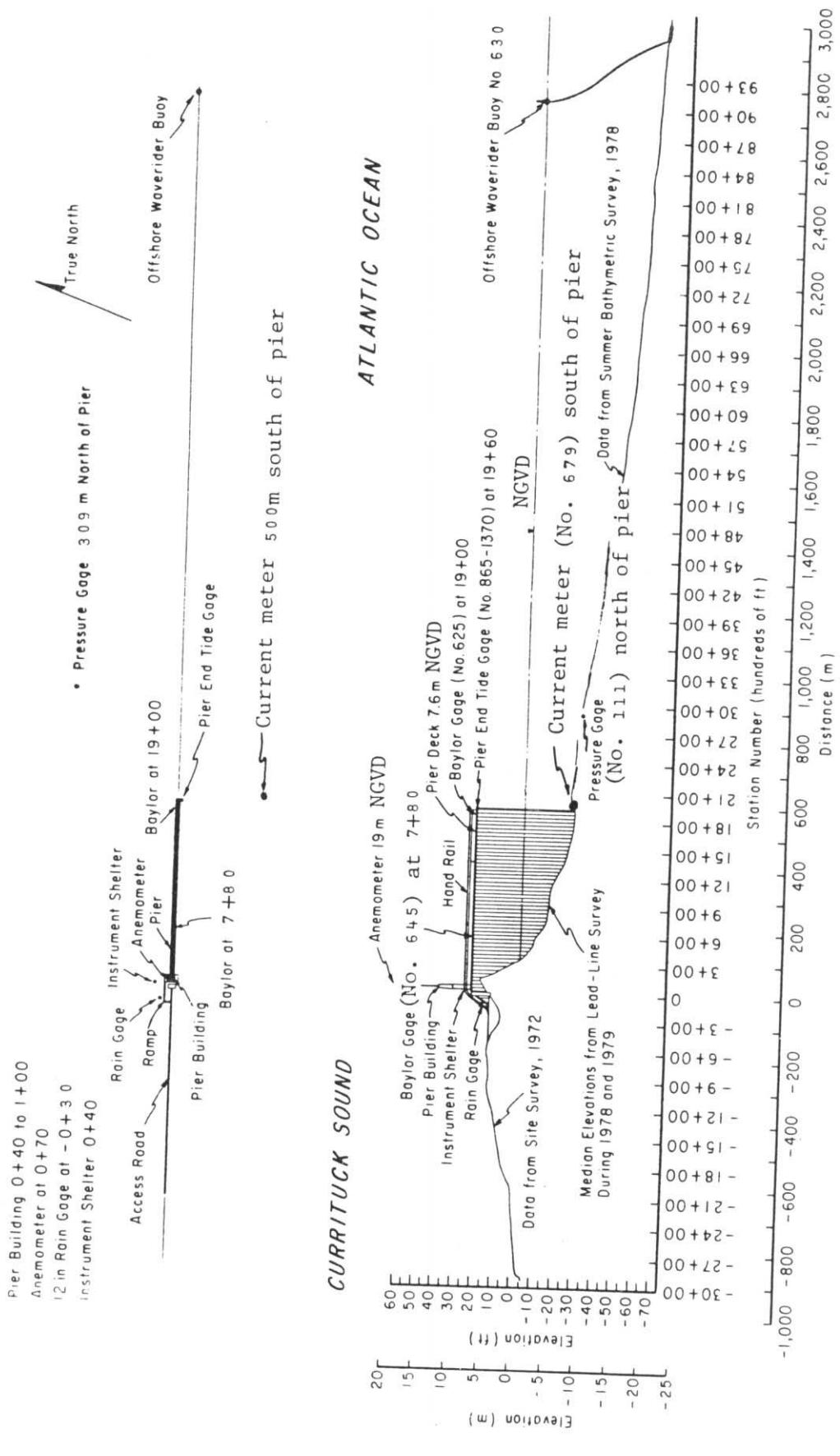
TABLE 1: INSTRUMENT STATUS/DATA AVAILABILITY

DEC 1987

Gage ID	Description/Remarks	Depth at Sensor	Day of the month																																								
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1										
616	Barometric Pressure		Gage Status Data Collected Analog Record	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
604	Precipitation		Gage Status Data Collected Analog Record	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
624	Air Temperature		Gage Status Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
632	Anemometer on Laboratory Building Elevation 19 m (NGVD)		Gage Status Data Collected Analog Record	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
625	Baylor staff at station 19+00 on FRF pier	see Figure 7	Gage Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
630	Waverider buoy 6.0 km offshore	Approx. 18 m NGVD	Gage Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
679	Current meter 500 m south of FRF pier (0.5 km offshore)	see Figure 7	Gage Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status Data Collected	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Supplemental Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

Figure 2. Instrument locations at FRF



## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in) -  
 $mm \times .03937 = in$
2. Millibars (mb) to inches of mercury (in Hg) -  
 $mb \times 0.02953 = in Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

TABLE 2: Meteorological Data

DEC 1987

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	4	29	9.1	1002.0	0
	700	3	12	8.2	1003.7	0
	1300	8	48	10.0	1002.6	0
	1900	8	48	9.8	1004.7	0
2	100	10	50	8.8	1006.0	0
	700	10	71	6.1	1011.8	0
	1300	6	45	10.0	1014.2	0
	1900	4	84	7.7	1017.5	0
3	100	3	79	5.2	1019.2	0
	700	2	89	5.1	1018.6	0
	1300	4	12	11.4	1013.1	0
	1900	5	94	9.8	1008.7	0
4	100	6	84	9.0	1004.7	0
	700	6	61	9.1	1000.3	0
	1300	10	85	9.1	999.9	0
	1900	9	91	6.3	1004.0	0
5	100	11	9	5.6	1007.4	0
	700	9	2	2.5	1012.1	0
	1300	8	15	6.3	1013.1	0
	1900	6	76	5.8	1015.5	0
6	100	8	100	2.5	1018.6	0
	700	6	99	1.2	1022.3	0
	1300	5	26	7.3	1023.3	0
	1900	2	75	3.2	1025.3	0
7	100	4	8	3.2	1027.0	0
	700	4	51	4.2	1029.4	0
	1300	5	57	7.9	1029.7	0
	1900	3	45	4.7	1030.4	0
8	100	3	62	4.9	1030.1	3
	700	5	54	8.6	1029.7	0
	1300	1	74	12.3	1027.7	0
	1900	3	52	9.8	1026.7	0
9	100	3	29	9.5	1023.6	0
	700	2	51	7.8	1022.3	0
	1300	5	44	14.8	1018.2	0
	1900	5	88	14.4	1016.2	0
10	100	4	11	13.2	1014.8	0
	700	4	98	13.4	1014.2	0
	1300	3	31	19.3	1010.4	0
	1900	6	82	16.8	1005.7	0
11	100	6	2	13.0	1001.6	10
	700	7	28	7.6	1006.4	0
	1300	3	37	11.1	1006.4	0
	1900	2	23	8.5	1006.0	0
12	100	4	88	8.4	1003.7	0
	700	8	44	9.8	1002.6	0
	1300	5	41	12.5	1002.3	0
	1900	5	47	10.4	1005.7	0
13	100	5	43	9.1	1008.7	0
	700	4	92	7.1	1014.8	0
	1300	3	36	10.4	1016.9	0
	1900	3	62	7.8	1020.3	0
14	100	6	54	8.9	1023.0	0
	700	4	38	8.3	1025.3	0
	1300	4	47	8.2	1024.3	0
	1900	5	72	8.3	1024.7	0
15	100	9	97	9.9	1020.3	0
	700	7	66	14.8	1015.2	0
	1300	8	87	17.2	1007.4	6
	1900	10	16	17.4	1002.3	0
16	100	8	68	12.5	1002.6	0
	700	9	87	6.3	1005.4	0
	1300	11	81	7.7	1005.4	0
	1900	11	76	5.8	1009.1	0

(Continued)

(Sheet 1 of 2)

TABLE 2: Meteorological Data

DEC 1987

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	Pressure mb	mm
17	100	12	81	3.5	1011.8	0
	700	12	83	2.2	1014.8	0
	1300	10	16	5.7	1017.2	0
	1900	5	25	3.8	1020.9	0
18	100	6	19	2.1	1023.0	0
	700	6	98	0.5	1025.7	0
	1300	7	3	4.7	1026.3	0
	1900	1	76	1.5	1027.4	0
19	100	3	1	2.4	1027.4	0
	700	6	33	3.8	1026.7	0
	1300	6	41	8.2	1024.0	0
	1900	3	88	6.8	1024.3	0
20	100	3	85	7.7	1023.6	0
	700	3	57	9.2	1021.3	0
	1300	8	8	16.6	1015.5	0
	1900	6	7	14.9	1015.2	0
21	100	4	32	12.4	1015.2	0
	700	4	46	10.2	1016.9	0
	1300	9	11	8.7	1018.9	0
	1900	6	41	7.1	1021.6	5
22	100	5	51	8.2	1020.6	0
	700	8	74	7.3	1019.2	4
	1300	3	66	9.8	1014.8	0
	1900	3	10	8.2	1012.8	0
23	100	8	89	7.3	1015.2	0
	700	4	7	5.4	1021.9	0
	1300	3	39	9.4	1024.7	0
	1900	2	86	6.1	1028.4	0
24	100	3	96	5.5	1028.4	0
	700	6	28	8.2	1029.1	0
	1300	7	34	11.8	1028.0	0
	1900	5	47	10.6	1026.0	0
25	100	4	86	13.1	1023.6	0
	700	4	91	13.2	1022.3	3
	1300	7	11	14.9	1019.6	0
	1900	7	6	15.5	1018.2	0
26	100	8	3	16.2	1015.5	0
	700	7	14	15.3	1015.2	0
	1300	9	50	10.4	1016.9	0
	1900	12	23	8.4	1021.9	0
27	100	9	29	8.0	1024.0	0
	700	8	28	8.3	1024.7	0
	1300	6	32	7.9	1023.6	0
	1900	6	37	6.5	1024.3	0
28	100	6	39	6.5	1022.6	0
	700	8	52	6.5	1020.3	5
	1300	10	64	6.7	1016.5	9
	1900	8	60	7.9	1011.1	0
29	100	5	35	8.0	1003.0	2
	700	9	99	4.4	1003.7	0
	1300	10	95	6.7	1007.0	0
	1900	11	27	2.0	1018.6	0
30	100	11	17	-1.6	1025.3	0
	700	10	26	-2.7	1030.1	0
	1300	7	25	1.6	1031.1	0
	1900	3	23	-0.4	1033.5	0
31	100	1	92	-0.7	1033.8	0
	700	4	81	1.9	1033.5	0
	1300	4	83	8.2	1030.4	0
	1900	5	87	7.5	1029.1	0
		Resultant 6	Mean 50	Mean 8.1	Total 1017.5	Total 47

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Paylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hrs (more frequently during storms) near 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for 34 minutes.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.





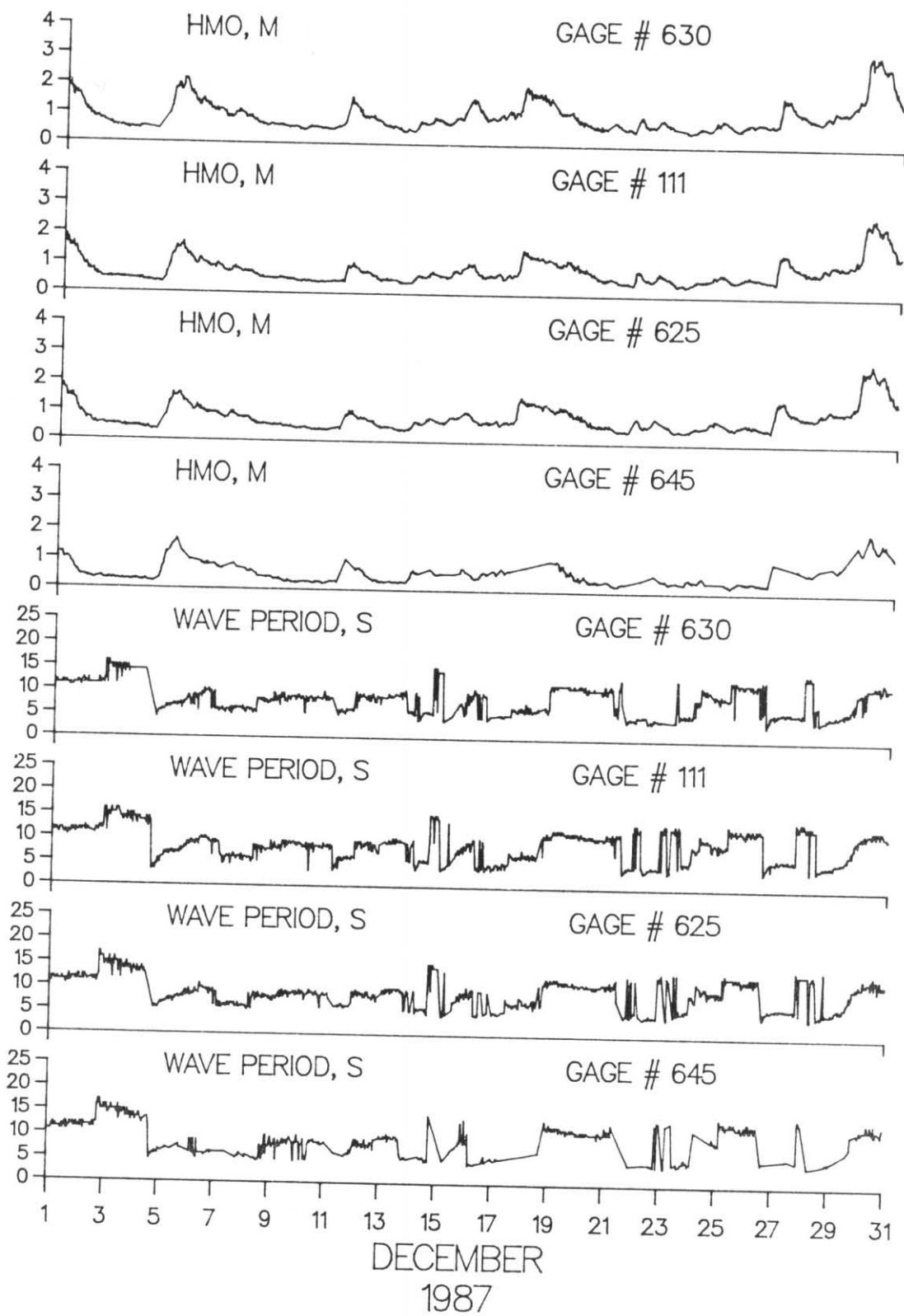


FIGURE 3. Time History of Wave Heights and Periods

#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

TABLE 4: Current Data  
DEC 1987

Day	Alongshore Cross-shore Resultant Time	Pier Measurements						Beach Measurements (500m Updrift)			Current Meter at South Tripod	
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
1	0100-Along Cross Result										9	S
1	0700-Along Cross Result	0			68	N			49	N	1	off
1	1300-Along Cross Result	0	0	152	0				South		9	154
1	1900-Along Cross Result				68	340					10	
2	0100-Along Cross Result										10	
2	0700-Along Cross Result	0			23	S					22	N
2	1300-Along Cross Result	0	0	152	28	off					6	on
2	1900-Along Cross Result				37	110					15	325
3	0100-Along Cross Result										15	
3	0700-Along Cross Result	17	N		7	N					5	
3	1300-Along Cross Result	7	off	152	29	off					9	322
3	1900-Along Cross Result	18	2		30	56					1	
4	0100-Along Cross Result										17	N
4	0700-Along Cross Result	0			6	S					1	on
4	1300-Along Cross Result	0	0	177	9	off					1	
4	1900-Along Cross Result				11	104					1	304
5	0100-Along Cross Result										1	
5	0700-Along Cross Result	76	S		102	S					1	on
5	1300-Along Cross Result	11	off	165	15	on					1	
5	1900-Along Cross Result	77	151		103	169					1	295
											17	
											31	S
											1	off
											31	158
											37	S
											2	off
											37	157
											29	S
											4	off
											29	152
											21	S
											4	off
											21	149

KEY = All speeds in CM/SEC  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Day	Time	Pier Measurements				Beach Measurements			Current Meter at South Tripod		
		Alongshore Cross-shore Resultant Speed	Cross-shore (579 m) (surface)	Dye at Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6	0100-Along Cross Result									18	S
										2	off
										18	154
6	0700-Along Cross Result	27	S			20	S	49	S	13	S
		7	off	152		20	on	North		1	off
		27	146			29	205			13	156
6	1300-Along Cross Result									21	S
										2	off
										21	155
6	1900-Along Cross Result									13	S
										5	off
										14	139
7	0100-Along Cross Result									5	S
										0	
										5	
7	0700-Along Cross Result	10	S			41	S	30	S	3	N
		3	on	213		10	on	North		1	on
		11	177			42	174			3	322
7	1300-Along Cross Result									7	S
										1	off
										7	152
7	1900-Along Cross Result									8	S
										0	
										8	
8	0100-Along Cross Result									8	S
										0	
										8	
8	0700-Along Cross Result	0				7	S	8	S	1	N
		5	on	140		2	on	North		1	on
		5	250			7	174			1	295
8	1300-Along Cross Result									7	S
										0	
										7	
8	1900-Along Cross Result									13	S
										2	off
										13	151
9	0100-Along Cross Result									10	S
										2	off
										10	149
9	0700-Along Cross Result	4	S			18	N	491	N	1	S
		1	off	140		6	off	North		4	off
		4	143			19	357			4	84
9	1300-Along Cross Result									5	S
										3	off
										6	129
9	1900-Along Cross Result									2	S
										1	on
										2	187
10	0100-Along Cross Result									2	N
										1	on
										2	313
10	0700-Along Cross Result	5	N			11	N	8	N	8	N
		2	off	152		3	off	South		3	on
		5	359			12	354			9	319
10	1300-Along Cross Result									0	
										0	
										0	
10	1900-Along Cross Result									4	S
										1	on
										4	174

KEY = All speeds in CM/SEC  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Day	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod	
	Alongshore Cross-shore Resultant Time	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	12m offshore (surface)	Location	Speed	Dir	Depth -4.8m (NGVD) ID #679
Speed	Dir	Speed	Dir	Speed	Dir	Speed	Dir	Speed	Dir
11 0100-Along Cross Result								10	S
11 0700-Along Cross Result	36 0	S off	41 10	S off	38	S	12 0	S	166
11 1300-Along Cross Result	36 160	177	42 146		North		12 1	S off	160
11 1900-Along Cross Result							12 1	S on	155
12 0100-Along Cross Result							9 1	S on	166
12 0700-Along Cross Result	15 6 16	N off 2	140	36 5 36	N off 349	10	N	8 3 9	160 N 319
12 1300-Along Cross Result							5 1	N off	351
12 1900-Along Cross Result							3 3	N off	
13 0100-Along Cross Result							4 5	S	25
13 0700-Along Cross Result	32 3 32	S off 154	152	5 0 5	S on 166	3	N	9 1 9	160 S 154
13 1300-Along Cross Result							10 2	S off	
13 1900-Along Cross Result							10 2	S off	149
14 0100-Along Cross Result							3 2	S	
14 0700-Along Cross Result	7 2 7	S on 177	165	10 7 12	N off 17	34	S	5 1 5	160 S 149
14 1300-Along Cross Result							1 0	S	
14 1900-Along Cross Result							1	S	160
15 0100-Along Cross Result							3 2	S	
15 0700-Along Cross Result	23 2 24	N off 346	177	61 6 61	N off 346	79	N	6 0 6	142 N 340
15 1300-Along Cross Result							19 3	N on	
15 1900-Along Cross Result							19 21 21	S N on	331 332

KEY = All speeds in CM/SEC

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Alongshore Cross-shore Resultant Time	Pier Measurements						Beach Measurements			Current Meter at South Tripod			
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	Depth -4.8m (NGVD) ID #679	
Day												Speed	Dir
16 0100-Along Cross Result												9	N
16 0700-Along Cross Result	18 7 20	S off 138		0 20 70				58	S	0 0 0			
16 1300-Along Cross Result										12 2 12	S on 169		
16 1900-Along Cross Result										8 1 8	S on 167		
17 0100-Along Cross Result										3 3 4	S on 205		
17 0700-Along Cross Result	32 3 32	S off 154		22 1 22	S off 157			27	S	8 0 8	S	160	
17 1300-Along Cross Result										24 2 24	S off 155		
17 1900-Along Cross Result										22 2 22	S off 155		
18 0100-Along Cross Result										21 1 21	S off 157		
18 0700-Along Cross Result	47 9 48	S off 149		87 22 90	S on 174			84	S	21 3 21	S off 152		
18 1300-Along Cross Result										21 3 21	S off 152		
18 1900-Along Cross Result										18 4 18	S off 147		
19 0100-Along Cross Result										9 1 9	S off 154		
19 0700-Along Cross Result	9 19 21	S off 95		19 19 27	S off 115			11	N	9 2 9	S off 147		
19 1300-Along Cross Result										4 6 7	N on 284		
19 1900-Along Cross Result										2 2 3	N off 25		
20 0100-Along Cross Result										5 3 6	N off 11		
20 0700-Along Cross Result	30 8 31	N off 354		76 0 76	N 0 340			24	N	4 1 4	N on 326		
20 1300-Along Cross Result										6 4 7	N on 306		
20 1900-Along Cross Result										6 4 7	N on 306		

KEY = All speeds in CM/SEC  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679				
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
21	0100-Along Cross Result											7	N
21	0700-Along Cross Result		30 S 8 off			76 S 15 off						2	on
21	1300-Along Cross Result		31 146			78 149				no observation		7	324
21	1900-Along Cross Result											8	N
22	0100-Along Cross Result											1	on
22	0700-Along Cross Result		8 N 13 off 16 39		140	20 5 5 on 21 326					13	S	
22	1300-Along Cross Result											1	off
22	1900-Along Cross Result											13	156
23	0100-Along Cross Result											14	S
23	0700-Along Cross Result		8 S 0 8 160		140	8 S 2 off 8 146					2	off	
23	1300-Along Cross Result											4	N
23	1900-Along Cross Result											9	154
24	0100-Along Cross Result											0	N
24	0700-Along Cross Result		28 N 0 28 340		140	47 5 5 on 47 334					4	on	
24	1300-Along Cross Result											4	340
24	1900-Along Cross Result											4	N
25	0100-Along Cross Result											1	on
25	0700-Along Cross Result		41 N 10 off 42 354		128	51 0 0 N 51 340					4	326	
25	1300-Along Cross Result											6	S
25	1900-Along Cross Result											2	off

KEY = All speeds in CM/SEC

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	Depth -4.8m (NGVD)
26 0100	Along Cross Result									3	N	
26 0700	Along Cross Result	0			23	N		24	N	5	on	
		10	off		140	2	on			6		281
		10	70		24	334						
26 1300	Along Cross Result									12		309
26 1900	Along Cross Result									3	S	
										1	on	
										3		178
27 0100	Along Cross Result									27	S	
										1	off	
										27		158
27 0700	Along Cross Result	24	S		36	S		46	S	23	S	
		6	on		165	4	on			1	off	
		25	174		36	166				23		158
27 1300	Along Cross Result									14	S	
										1	off	
										14		156
27 1900	Along Cross Result									0	S	
										14		
28 0100	Along Cross Result									9	S	
										1	off	
										9		154
28 0700	Along Cross Result	29	S		0			23	S	13	S	
		15	on		165	12	on			1	off	
		32	187			12	250			13		156
28 1300	Along Cross Result									10	S	
										1	off	
										10		154
28 1900	Along Cross Result									9	S	
										1	off	
										9		154
29 0100	Along Cross Result									12	S	
										0		
										12		160
29 0700	Along Cross Result	51	S		68	S		87	S	22	S	
		5	off		152	85	off			0		
		51	154			108	109			22		160
29 1300	Along Cross Result									20	S	
										2	on	
										20		166
29 1900	Along Cross Result									61	S	
										6	off	
										61		154
30 0100	Along Cross Result									51	S	
										2	off	
										51		158
30 0700	Along Cross Result	76	S		61	S		122	S	44	S	
		0			140	37	off			3	off	
		76	160			71	129			44		156
30 1300	Along Cross Result									34	S	
										0		
										34		160
30 1900	Along Cross Result									14	S	
										3	on	
										14		172

KEY = All speeds in CM/SEC  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

TABLE 4: Current Data  
DEC 1987

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod	
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed   Dir	Dye Zone (surface)	12m offshore (surface)	Location	Speed   Dir	Depth -4.8m (NGVD)
31	0100-Along Cross Result								5	S
31	0700-Along Cross Result	32 5	N off	152	28 6	N on	50	S	7	N
31	1300-Along Cross Result	32 349			28 329		South		3 8	on 317
31	1900-Along Cross Result								22 23 23 4	N on 325 on
									23	330

KEY = All speeds in CM/SEC  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore      off = offshore

#### PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) taken at the seaward end of the pier are made of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves). The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are made daily at the seaward end of the FRF pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A secci disc is used to determine the surface visibility.

TABLE 5: Supplemental Observations

DEC 1987

DAY	TIME	WAVE APPROACH ANGLE AT PIER END		RADAR WAVE ANGLE deg from True N	WIDTH OF SURF ZONE, m	WATER CHARACTERISTICS AT PIER END		
		Primary	Secondary			TEMP, C	DENSITY g/cc	SECCI VIS, m
1	745	80	50		195	11.7	1.0228	0.6
2	950	65	355	40	34	11.4	1.0228	0.3
3	906	55			54	11.7	1.0230	0.6
4	733	80			24	12.2	1.0236	1.8
5	952	30		50	110	10.0	1.0238	0.3
6	945	50	30		137	9.5	1.0242	0.9
7	735	40		60	43	10.0	1.0235	2.1
8	910	40	100	60	18	10.0	1.0240	1.2
9	930	55	130		11	10.6	1.0232	1.2
10	730	90			24	10.6	1.0231	1.5
11	730	30		50	67	10.0	1.0240	1.2
12	955	80	45		18	11.1	1.0240	0.9
13	825	60	10		17	10.0	1.0238	0.9
14	735	40		50	43	10.0	1.0232	2.7
15	745	60		60	61	10.6	1.0232	1.8
16	730	40		55	55	10.0	1.0238	0.9
17	730	30		50	50	8.9	1.0236	0.9
18	800	40	80	50	70	7.8	1.0235	0.3
19	955	80			116	8.0	1.0232	1.2
20	945	80	135		20	9.5	1.0300	1.8
21	1325	50	25	60	55	8.9	1.0230	1.2
22	734	90	60	55	30	9.7	1.0236	0.9
23	735	30			2	9.0	1.0233	1.5
24	945	70		70	73	8.9	1.0248	0.9
25	1030	75			12	11.1	1.0230	0.9
26	1130	110			12	11.7	1.0254	1.2
27	1000	55			73	8.9	1.0240	0.9
28	840	65	45	60	85	8.4	1.0236	1.2
29	853	70	45	60	105	8.6	1.0232	1.5
30	850	55		70	398	6.4	1.0218	0.3
31	1015	55			171	7.8	1.0220	0.3

## PART VI: WATER LEVELS

The National Ocean Services (NOS) has established a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect data every 6 minutes throughout the month.

Figure 4 shows the variation in mean water levels computed over a tidal cycle period (12.42 hours) and contains a list of selected mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water levels.

Table 6 contains the time of the center of each sampling interval and the range, high, low, and mean water levels during each tidal cycle.

FRF TIDE HEIGHTS  
DEC 1987

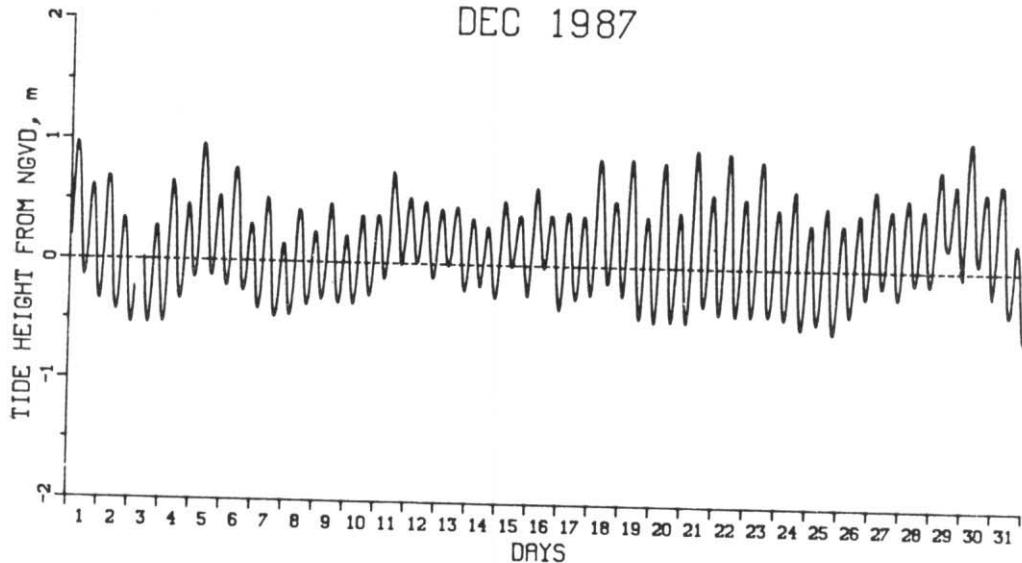


FIGURE 4. Time History of Mean Water Levels

MONTHLY WATER LEVELS (METERS NGVD)

EXTREME LOW = -0.60 ON DAY 31 AT 2324HRS.  
EXTREME HIGH = 1.08 ON DAY 30 AT 406HRS.  
MONTHLY MEAN = 0.14  
MEAN LOW = -0.29  
MEAN HIGH = 0.57  
MEAN RANGE = 0.86

Table 6: WATER LEVELS, METERS NGVD

		DEC 1987			
MID-CYCLE DAY	TIME	LOW	HIGH	MEAN	RANGE
1	612	-0.15	0.97	0.44	1.12
1	1837	-0.34	0.62	0.14	0.96
2	703	-0.43	0.69	0.16	1.12
2	1928	-0.54	0.34	-0.11	0.88
3	753				
3	2018	-0.53	0.28	-0.15	0.81
4	843	-0.39	0.66	0.15	1.05
4	2109	-0.29	0.47	0.10	0.76
5	934	-0.13	0.97	0.44	1.09
5	2159	-0.22	0.54	0.14	0.76
6	1024	-0.25	0.77	0.28	1.03
6	2249	-0.40	0.31	-0.04	0.71
7	1115	-0.47	0.53	0.03	1.00
7	2340	-0.45	0.15	-0.17	0.60
8	1205	-0.36	0.43	0.03	0.80
9	30	-0.31	0.25	-0.05	0.56
9	1255	-0.34	0.49	0.07	0.83
10	121	-0.35	0.22	-0.08	0.57
10	1346	-0.28	0.39	0.04	0.67
11	211	-0.13	0.40	0.12	0.54
11	1436	-0.02	0.76	0.36	0.77
12	301	0.01	0.55	0.27	0.54
12	1527	-0.12	0.52	0.20	0.64
13	352	-0.02	0.46	0.20	0.48
13	1617	-0.22	0.48	0.15	0.70
14	442	-0.19	0.38	0.10	0.57
14	1707	-0.28	0.32	0.02	0.60
15	532	-0.05	0.53	0.23	0.58
15	1758	-0.26	0.42	0.10	0.68
16	623	-0.02	0.65	0.28	0.67
16	1848	-0.37	0.42	0.06	0.80
17	713	-0.28	0.45	0.08	0.73
17	1938	-0.25	0.42	0.08	0.67
18	804	-0.14	0.90	0.39	1.04
18	2029	-0.25	0.55	0.17	0.80
19	854	-0.44	0.90	0.26	1.34
19	2119	-0.47	0.42	-0.02	0.89
20	944	-0.46	0.87	0.23	1.34
20	2210	-0.47	0.46	-0.02	0.93
21	1035	-0.32	0.98	0.32	1.30
21	2300	-0.39	0.61	0.11	1.00
22	1125	-0.40	0.96	0.27	1.36
22	2350	-0.40	0.59	0.08	0.99
23	1216	-0.40	0.90	0.24	1.30
24	41	-0.42	0.50	0.02	0.92
24	1306	-0.51	0.66	0.06	1.16
25	131	-0.46	0.38	-0.07	0.84
25	1356	-0.54	0.52	-0.02	1.06
26	222	-0.42	0.38	-0.02	0.80
26	1447	-0.30	0.47	0.08	0.77
27	312	-0.14	0.67	0.25	0.81
27	1537	-0.24	0.51	0.14	0.75
28	402	-0.16	0.60	0.22	0.77
28	1628	-0.12	0.52	0.18	0.64
29	453	-0.04	0.84	0.45	0.88
29	1718	-0.05	0.73	0.35	0.79
30	543	0.06	1.08	0.57	1.02
30	1808	-0.21	0.66	0.27	0.88
31	634	-0.37	0.73	0.23	1.10
31	1859	-0.60	0.24	-0.15	0.84

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in November and the three surveys in December on profile line 188, located 517 m south of the pier. Up to 0.75 m of accretion occurred on the foreshore (80 to 120 m), while the nearshore bar (120 to 250 m) migrated first shoreward then seaward of its original location. Only minor changes are visible on the remainder of the profile line.

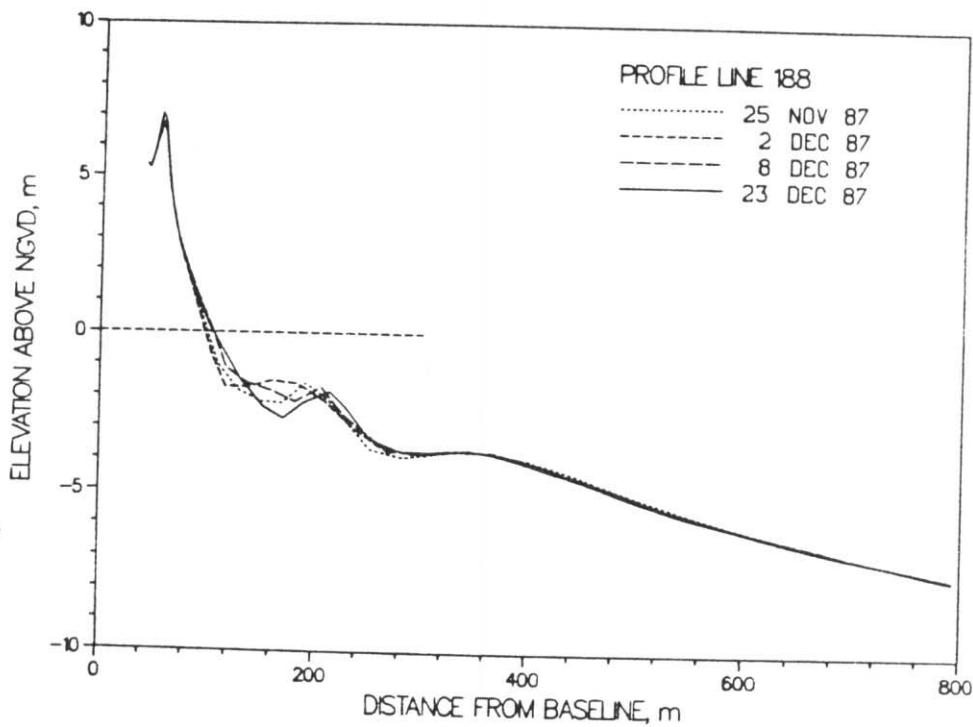


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1987.

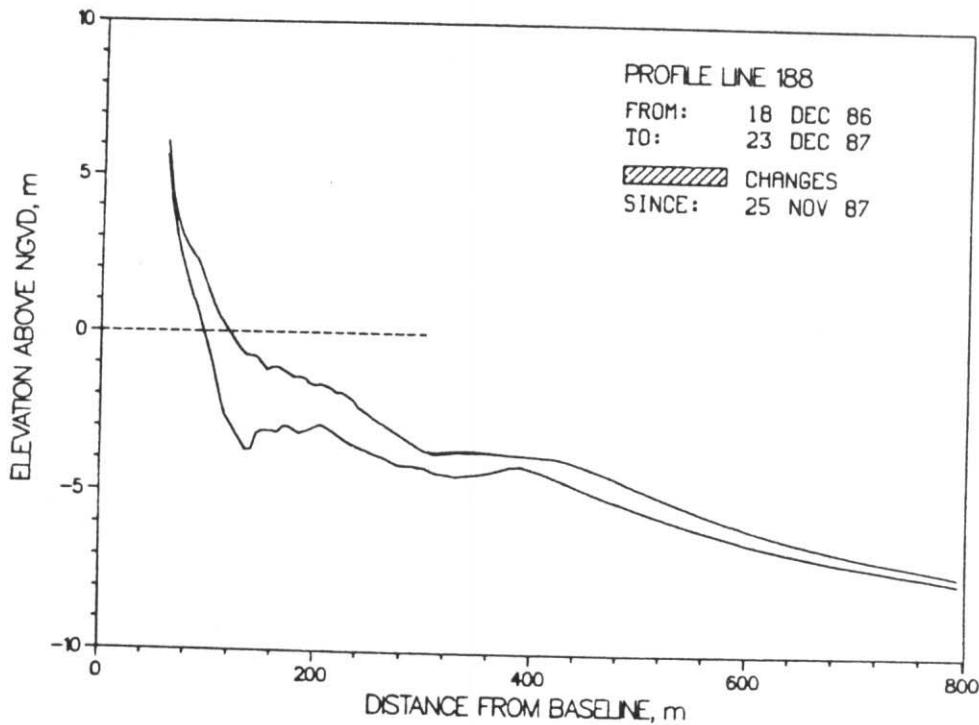


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. No bathymetric survey was conducted in November. The September bathymetry (Figure 7) is given for reference.

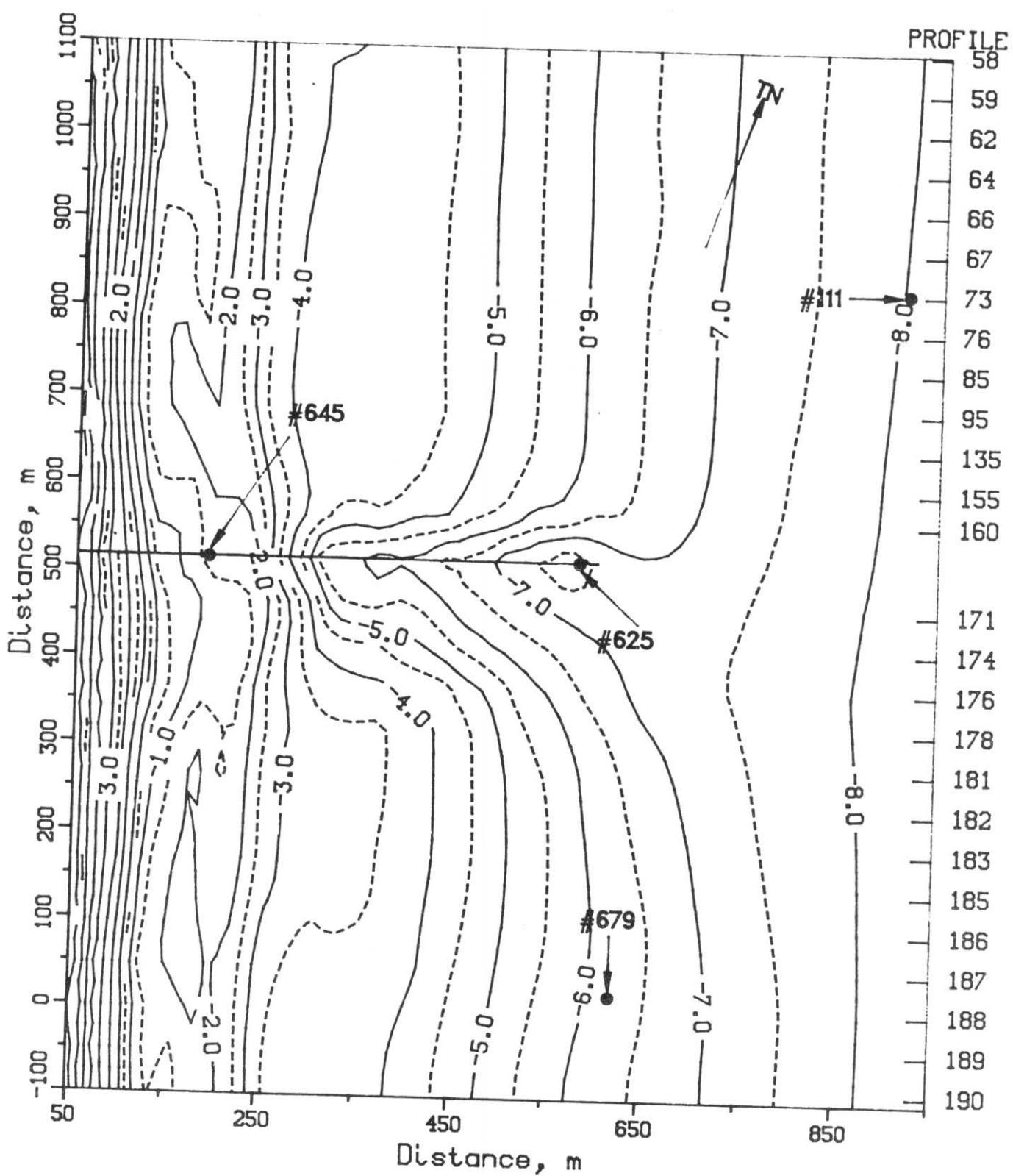


Figure 7. FRF BATHYMETRY 9 DEC 87  
 CONTOURS IN METERS

PART VIII: SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the wave height at the seaward end of the pier (i.e. as measured by Baylor Gage #625 at pier station 19+00) exceeded 2 m. When this occurred, four contiguous 34-min wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
29 Dec (1634)	30 Dec (1442)

B. Storm Synopsis.

29-30 December - This storm formed off Cape Hatteras, NC early on 29 December and rapidly strengthened as it quickly moved up the east coast. It was located off Nova Scotia, Canada by 30 December. Maximum onshore winds (from north-northeast) approached 14 m/s at 2042 hr on the 29th; five hours later the maximum  $H_{mo}$  of 2.79 m ( $T_p = 11.13$  sec) was recorded; and the minimum barometric pressure of 1001.8 mb occurred on the 29th at 0434 hr. Precipitation totalled 16 mm.

### Distribution List

#### Government Agencies:

OCE  
BERH  
NAO  
NASA/Wallops Flight Center  
NOAA (NOS, NWS)  
SAD  
SAW

U.S. Geological Survey  
U.S. National Park Service  
U.S. Naval Academy  
U.S. Naval Civil Eng. Lab  
U.S. Naval Fac. Eng. Com.  
U.S. Naval Oceanographic Off.  
U.S. Naval Research Lab

#### Colleges/Universities:

California Inst. of Tech.  
East Carolina University  
Florida Inst. of Tech.  
Harvard University  
Naval Post Graduate School  
NC State University  
Old Dominion University  
Oregon State University  
Prince George's College  
Rutgers University  
Scripps Inst. of Oceanography  
Southern Illinois University

Stockton State College  
University of Akron  
University of Delaware  
University of Florida  
University of Maryland  
University of Miami  
University of North Carolina  
University of N. Colorado  
University of Rhode Island  
University of Virginia  
Va. Inst. of Marine Science

#### Others:

City of Va. Beach, VA  
Coastal Barge Corporation  
Coastal and Est. Res., Inc.  
Coastal Science & Eng., Inc.  
Dr. Galvin  
GEOMET Tech., Inc.  
Greenhorne & O'Mara, Inc.  
Dr. Hylton  
Mary Marr, Inc.  
Masonite Corporation

MEC Systems Corporation  
Moffatt & Nichol, Eng.  
Offshore Coastal Technologies  
Mr. Rowland  
Mr. Savage  
Sea Port Supply Corp.  
Shell Development  
Sherwood Industries  
Mr. & Mrs. Valpey  
WCTI-TV

#### Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)  
Queen's University, Ontario (Canada)  
Ministry of Construction, Coastal Division (Japan)  
Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)